Morphological and crystallographic variation of coccoliths in *Umbilicosphaera* (Calcidiscaceae) lineage

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Morphology of the placolith-type coccolith is unique to the given species, characterized by the size of the distal and proximal shields, diameter of central opening, and shape of the suture lines, etc. These characters are basically determined by the shapes of the organic base plate and coccolith vesicle enfolding the plate, and the crystal orientation of the initially precipitated calcite at the rim of the plate. Analysis using high-resolution scanning electron microscopy (SEM) and electron back-scattered diffraction (EBSD) enables to understand the relationship between the crystallographic orientations of the shield elements and morphologies of coccolith (e.g. Saruwatari et al., 2006). Such analysis will allow us to understand what controls the species-specific morphology and what has changed in the evolutionary lineage of coccolithophore. For this purpose, SEM-EBSD analysis of several taxa with direct ancestor-descendant relationships is expected, but there is no example of such studies in our knowledge. The genus *Umbilicosphaera* Lohman, which is the subject of the present study, has a fossil record that runs from the upper Paleocene. *Umbillicosphaera patera* newly described by Utsunomiya et al. (2021) is considered as the most recent common ancestor of the extant species *Umbilicosphaera sibogae*. The diversifications of *U. sibogae* from *U. patera* occurred during the Pliocene. We obtained morphometric data and measured **c**- and $\mathbf{a}_i$-axes orientations of the distal shield elements around the central opening for these two species using SEM-EBSD. The **c**-axis of distal shield element of *U. patera* inclines upward with ~55° from the coccolith plane, and one of the $\mathbf{a}_i$-axes is roughly parallel to the coccolith plane. On the other hand, the **c**-axis of distal shield element of *U. sibogae* inclines upward with ~65° from the coccolith plane. This difference in the crystal orientation can explain nearly flat distal shield and steep inner slope around central opening in the morphology of *U. patera* compared to those of *U. sibogae*, assuming that the facets of the distal shield elements consist of {104} planes of calcite.

References:

Saruwatari, K., Ozaki, N., Nagasawa, H. & Kogure, T. 2006. Crystallographic alignments in a coccolith (*Pleurochrysis carterae*) revealed by electron back-scattered diffraction (EBSD). *American Mineralogist* **91**: 1937–1940.

Utsunomiya, M., Hagino, K. & Tanaka, Y. 2021. Speciation of extant *Umbilicosphaera* (Prymnesiophyceae) during the Pliocene. *Marine Micropaleontology* **169**: 102037.